[0028] Known systems also include an adaptive baseline, in which an amplitude of the normal received signal over time is stored, and the received signal is compared to a baseline having a characteristic timeframe. In this system, an artifact in one position does not necessarily reduce sensitivity at another.

[0029] Brenner et al., U.S. Pat. No. 4,644,100 relates to a touch sensitive system employing surface acoustic waves, responsive to both the location and magnitude of a perturbation of the surface acoustic waves. The system according to U.S. Pat. No. 4,644,100 is similar in execution to the system according to US Re. 33,151, while determining an amplitude of a received wave and comparing it to a stored reference profile.

[0030] In order to reduce the number of transducers, the known "triple transit" system reflects the acoustic signal so that a wave emitted by a single transducer is dispersed as parallel waves along a first axis, then reflected at a right angle and dispersed as parallel waves along a second axis. These waves are then reflected back to the arrays and then back to the transducer, so that all the waves traveling along the first axis are received by the transducer prior to any waves traveling along the second axis, generally requiring an oblong substrate. The controller therefore sets two non-overlapping time windows for the received signal, a first window for the first axis and a second window for the second axis. Therefore, each time window is analyzed conventionally, and the pair of Cartesian coordinates is resolved.

[0031] A system for sensing a force of a stylus against an acoustic touch-sensitive substrate is disclosed in U.S. Pat. No. 5,451,723, incorporated herein by reference. This system converts the point-contact of the rigid stylus portion into an area contact of an acoustically absorptive elastomer, placed between the stylus and the substrate.

[0032] e. Wave Modes

[0033] "Surface acoustic waves" ("SAW"), as used herein refers to acoustic waves for which a touch on the surface leads to a measurable attenuation of acoustic energy. Several examples of surface acoustic waves are known.

[0034] The vast majority of present commercial products are based on Rayleigh waves. Rayleigh waves maintain a useful power density at the touch surface due to the fact that they are bound to the touch surface. Mathematically, Rayleigh waves exist only in semi-infinite media. In practice it is sufficient for the substrate to be 3 or 4 wavelengths in thickness. In this case one has quasi-Rayleigh waves that are practical equivalents to Rayleigh waves. In this context, it is understood that Rayleigh waves exist only in theory and therefore a reference thereto indicates a quasi-Rayleigh wave.

[0035] Like Rayleigh waves, Love waves are "surface-bound waves". Particle motion is vertical and longitudinal for Rayleigh waves. Both shear and pressure/tension stresses are associated with Rayleigh waves. In contrast, particle motion is horizontal, i.e. parallel to touch surface, for Love waves. Only shear stress is associated with a Love wave. Other surface-bound waves are known.

[0036] Another class of surface acoustic waves of possible interest in connection with acoustic touchscreens are plate waves. Unlike surface-bound waves, plate waves require the confining effects of both the top and bottom surfaces of the substrate to maintain a useful power density at the touch surface. Examples of plate waves include symmetric and anti-symmetric Lamb waves, zeroth order horizontally polarized shear (ZOHPS) waves, and higher order horizontally polarized shear (HOHPS) waves.

[0037] The choice of acoustic mode affects touch sensitivity, the relative touch sensitivity between water drops and finger touches, as well as a number of sensor design details. However, the basic principles of acoustic touchscreen operation are largely independent of the choice of acoustic mode.

[0038] f. Optimization for Environmental Conditions

[0039] The exposed surface of a touchscreen is ordinarily glass. While certain systems may include such additions, electrically conductive coatings or cover sheets are not necessary. Therefore, acoustic touchscreens are particularly attractive for applications which depend on public access to a durable touch interface.

[0040] Semi-outdoor applications, e.g., ATMs, ticket booths, etc., are of particular interest. Typically in such applications, the touchscreen is protected from direct environmental precipitation contact by a booth or overhang. However, indirect water contact, due to user transfer or condensation is possible. Thus, users coming out of the rain or snow with wet clothes, gloves or umbrellas are likely to leave occasional drops of water on the touchscreen surface. Water droplets have a high absorption of Rayleigh waves in known systems; thus, a drop of water in the active region will shadow the acoustic paths intersecting that drop, preventing normal detection of a touch along those axes.

[0041] One approach to limit water contact with the touchscreen surface is to employ a cover sheet. See U.S. Pat. No. 5,451,723. However, a cover sheet generally reduces the optical quality of the displayed image seen through the resulting sensor and leads to a less durable exposed surface. Another approach to reducing the effects of water droplets is to employ a wave mode which is less affected by the droplets, such as a low frequency Rayleigh wave, see U.S. Pat. No. 5,334,805, a Lamb wave, see U.S. Pat. Nos. 5,072,427 and 5,162,618, or a zero order horizontally polarized shear wave, see U.S. Pat. No. 5,260,521. These waves, however, also have reduced sensitivity, resulting in either reduced touch sensitivity of the touch system, increased susceptibility to electromagnetic interference, or more expensive controller circuitry.

[0042] In the case of Rayleigh waves, a lower frequency operation requires a thicker substrate, e.g., 3 to 4 wavelengths of the wave, and wider reflective arrays and transducers. The increased bulk of a sensor designed for low-frequency Rayleigh waves is typically a serious mechanical design problem. In the case of Lamb waves, a thin substrate is required, e.g., about 1 mm at about 5 MHz. These thin substrates are fragile, and Lamb waves have energy on both top and bottom surfaces, making optical bonding problematic due to signal damping. In the case of a ZOHPS wave, in contrast to a Rayleigh wave, the relative sensitivity is greater to a finger than to water droplets. Further, ZOHPS waves support limited options for optical bonding, such as RTVs (silicone rubbers) which do not support shear radiation damping.